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Buckling Instabilities and Complex Dynamics in a Model of Uniflagellar Bacterial Locomotion[1] FRANK NGUYEN, MICHAEL GRAHAM, University of Wisconsin, Madison — Locomotion of microorganisms at low Reynolds number is a long studied problem. Of particular interest are organisms using a single flagellum to undergo a wide range of motions: pushing, pulling, and tumbling or flicking. Recent experiments have connected the stability of the hook protein, connecting cell motor and flagellum, to deviations from typical straight swimming trajectories. We seek physical explanations to these phenomena by developing a computationally inexpensive, rigid-body dynamic model of a uniflagellated organism with a flexible hook connection that captures the fundamental dynamics, kinematics, and configurations. Furthermore, the model addresses the effects of hook loading and geometry on the stability of the system. Simulations with low hook flexibility produce the classic straight trajectory, but a large flexibility produces helical trajectories, leading to directional changes when coupled with transient hook stiffening. Minima for critical flexibilities are found in certain subsets of parameter space, implying preferred geometries for certain swimming dynamics. The model verifies proposed mechanisms for swimming in various modes and highlights the role of flexibility in the biology of real organisms and the engineering of artificial microswimmers.

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